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SEASONAL VARIATIONS OF CRUDE PROTEIN AND PHOSPHORUS
IN FOUR RANGE PLANTS USED FOR RESEEDING

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A number of studies have been made of the chemical composition of herbaceous plants at various stages of growth. In general these studies, principally on cultivated crops, have pointed out that crude protein and phosphorus are high during the early part of the growing season and decrease as the plants reach maturity and become dry.

This study was made in central Utah to secure information on the seasonal content of crude protein and phosphorus of four range plants--three grasses and one legume--in three different climatic zones. Collection of plant samples was begun in 1942 and analysis was made in subsequent years.

The species studied were crested wheatgrass (Agropyron cristatum), slender wheatgrass (A. trachycaulum), smooth brome (Bromus inermis), and American vetch (Vicia americana). All plants had been seeded several years before, and were protected from grazing and well established. The three study sites were as follows: (1) valley site (Sorenson Field), (2) foothill site (Majors Flat), and (3) high mountain site (Great Basin Station headquarters).

The valley site is just east of the town of Ephraim at an elevation of 5,500 feet and has an average annual precipitation of about 11 inches. The soil is a shallow, sandy silt loam low in organic matter. Plant cover was predominantly sagebrush before the area was reseeded. The foothill site is about 5 miles up Ephraim Canyon at an elevation of 7,200 feet. Annual precipitation is estimated to be about 14 inches. The soil is a deep, sandy silt loam moderately high in organic matter. The natural cover is largely oakbrush with some serviceberry and sagebrush in the openings. The high mountain site is located at an elevation of 8,850 feet and has an annual precipitation of about 28 inches. The soil is deep silt loam, rich in organic matter and of high water-holding capacity. The aspen-fir cover has abundant snowberry and some elderberry in the understory.

The three grasses are standard species recommended for range reseeding. American vetch commonly grows in the aspen-fir zone. The grasses grow well at all three sites, but crested wheatgrass is best adapted at the valley and foothill sites (sagebrush and mountain brush zones), slender wheatgrass at the foothill site (mountain brush zone), and smooth brome at the foothill and high mountain sites (mountain brush and aspen-fir zones).

The plants start growth soon after snow melt at all three study sites, usually reaching maturity near the end of June at the valley site, late in July in the foothills, and near the end of August at the high mountain site. In early June when observations began, crested wheatgrass, the earliest growing of the grasses, was about 6 inches tall and well vegetated in the valley, 3 inches tall with few leaves in the high mountains, and in an intermediate stage of growth in the foothills. The other grasses were somewhat less advanced.

Study Methods

Sample plants were clipped at random every 15 days from the time of early growth until the plants reached maturity. The herbage was put in cloth bags and hung to dry in a shed protected from moisture but having good ventilation. When the samples reached a constant air-dry weight they were ground in a ball mill and stored in dry containers at approximately room temperatures until analyzed.

Moisture determinations were made on the air-dry plant material and all results were calculated to the oven-dry basis. Analyses for crude protein and phosphorus were made according to the methods of the Association of Official Agricultural Chemists. Phosphorus was determined volumetrically by means of the standard molybdate method.

Results

The seasonal changes in crude protein and phosphorus content of the range plants studied are shown in table 1. These are recorded for each of the three zones from which the plants were collected. The ratio of phosphorus to crude protein is also given for each species.

As table 1 shows, all plants had the highest percentage of crude protein and phosphorus at the beginning of the growth period. The concentration of these substances dropped rapidly as the plants became older. This same trend has been noted by other workers (2, 3, 5, 6). 1/

1/ Numbers in parentheses (underscores) refer to Literature Cited, p. 5.



Table 1.--Crude protein and phosphorus contents (in percent) of four forage plants sampled at 15-day intervals at three different elevational sites in central Utah

Date	Valley			Foothills			High Mountains		
	Crude Protein	P 2 O 5	Ratio Prot./P	Crude Protein	P 2 O 5	Ratio Prot./P.	Crude Protein	P 2 O 5	Ratio Prot./P.
Crested wheatgrass									
6/3	16.69	0.63	26.4	16.55	0.78	21.2	16.87	1.17	14.4
6/17	11.80	.42	28.1	13.90	.68	20.4	14.36	.90	16.0
7/1	6.40	.29	22.0	7.92	.47	16.8	14.10	.60	23.5
7/17	6.25	.29	21.6	6.40	.58	11.0	10.80	.58	18.6
7/30	-	-	-	6.00	.47	12.8	10.29	.47	21.9
8/13	-	-	-	6.00	.39	15.4	9.74	.35	27.8
8/27	-	-	-	5.31	.38	14.0	7.50	.33	22.8
9/10	-	-	-	-	-	-	5.58	.32	17.4
10/9	-	-	-	-	-	-	3.72	.29	12.8
Slender wheatgrass									
6/3	14.78	0.42	35.2	16.18	0.94	17.2	29.75	1.56	19.1
6/17	10.61	.43	24.7	9.77	.55	17.8	21.60	.83	26.0
7/1	8.25	.41	20.1	9.75	.59	16.5	15.82	.74	21.4
7/17	-	-	-	9.75	.52	18.7	13.20	.69	19.2
7/30	-	-	-	-	-	-	11.25	.60	18.7
8/13	-	-	-	5.62	.46	12.2	-	-	-
8/27	-	-	-	5.25	.38	13.8	4.50	.24	18.7
9/10	-	-	-	-	-	-	3.62	.19	19.0
9/30	-	-	-	6.12	.42	14.6	-	-	-
10/9	-	-	-	-	-	-	4.17	.22	19.0
Smooth brome									
6/3	13.68	0.86	15.9	12.37	0.89	13.9	23.68	1.18	20.0
6/17	11.50	.37	31.1	10.11	.63	16.1	20.60	.76	27.1
7/1	9.75	.35	27.8	9.25	.48	19.3	15.90	.64	24.8
7/17	8.06	.24	33.6	6.77	.40	16.9	10.41	.53	19.7
7/30	-	-	-	5.35	.39	13.7	12.50	.45	27.8
8/13	-	-	-	4.68	.50	9.4	9.00	.48	18.7
8/27	-	-	-	4.25	.31	13.7	5.25	.23	22.8
9/10	-	-	-	-	-	-	7.92	.31	25.6
10/9	-	-	-	-	-	-	3.65	.23	15.8
American vetch									
6/3	-	-	-	-	-	-	35.20	1.54	22.8
6/17	-	-	-	-	-	-	25.20	.93	27.1
7/1	-	-	-	-	-	-	22.50	.83	27.0
7/17	-	-	-	-	-	-	20.60	.63	32.7
7/30	-	-	-	-	-	-	18.05	.57	31.6
8/13	-	-	-	-	-	-	12.20	.47	26.0
8/27	-	-	-	-	-	-	13.50	.40	33.7
9/10	-	-	-	-	-	-	10.60	.37	28.6
10/9	-	-	-	-	-	-	7.81	.28	27.9

Alberda (1) in a study of the influence of phosphate uptake of maize plants in culture solutions pointed out that the phosphorus absorption by plants is independent of other anions. Some indications were obtained in this study which substantiate this conclusion. In a particular climatic zone, the crude protein content varied considerably on a given date for different plant species whereas the variation in phosphorus content was not so noticeable. These facts seemed to be more evident when comparing results in the high mountain zone with those in the foothill zone from the middle to the late part of the season.

The ratio of crude protein to phosphorus as shown in table 1 decreased in most cases as the plants reached maturity, but it also varied considerably throughout the growing season, indicating independent uptake of these anions.

Crested wheatgrass had approximately the same crude protein concentration early in the growing season at all study locations due to its early growth habit. In contrast, the other two grasses varied considerably in protein content between the high mountain zone and the two lower zones early in the season.

Stanley and Hodgson (6) in studying the total ash content of grass plants at various stages of growth found no definite trend. In the present study no attempt was made to follow the trends of total ash content in plants, but it was observed that the ash material of some plants effervesced after addition of acid while in others no effervescence was noted. The effervescence was taken to indicate the presence of carbonates. These results indicated that presence of carbonates was not due to the zone or type of soil on which the plants were grown, but seemed to vary with the stage of plant growth. This seemed to be true especially of the ash from crested wheatgrass and smooth brome. The effervescence was greatest in the young plants and decreased rapidly as the plants approached maturity.

The seasonal trends observed during the year when this information was gathered for the most part agree with those of other investigators who have worked largely with grasses grown on one site on cultivated land. McCreary, Cundy, Cruickshank, Stanley and Hodgson, and others have made studies of the chemical composition of plants at various stages of growth and obtained similar results.

Summary

Herbage samples of three range grasses--crested wheatgrass, slender wheatgrass, and smooth brome--and one legume--American vetch-- were collected every 15 days during the growing season from range sites at three elevations. Studies were conducted at a valley site, a foothill site, and a high mountain site in central Utah. Samples were later analyzed for crude protein and phosphorus content.



This analysis showed the following relations:

1. Crude protein and phosphorus contents for all plants were highest early in the growing season and decreased rather steadily to a low level at maturity.
2. Throughout the period of study, the content of crude protein was considerably higher in American vetch than in the grasses at comparable growth periods. The three grasses were essentially similar in content of crude protein and phosphorus at similar stages of growth, although these differed according to location; the period of growth for the species studied increased with increase in elevation. Crude protein and phosphorus contents of slender wheatgrass and smooth brome were markedly greater at the study site of highest elevation early in the season; those of crested wheatgrass were more uniform at all sites due to its earlier growth.
3. There was an indication of separate uptake of the two anions.

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